Numerical analysis of electrorheological fluids

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We study a priori estimates for the finite element solutions of electrorheological fluids. These fluids may change their viscosity significantly if an electrical field is applied. Different from the Newtonian case (like water), the friction depends non-linearly on the symmetric gradient of the velocity (power law ansatz). In the case of electrorheological fluids this power is depending additionally on the applied electrical field. We explain step by step the difficulties of the numerical analysis. We start with the p-Laplace system, continue with the p-Stokes system and finally discuss the system for electrorheological fluids. The last step requires the use of Lebesgue spaces with variable exponents.